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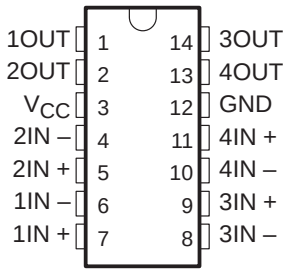
Jameco Part Number 121099



SLCS004A – OCTOBER 1987 – REVISED MAY 1988

- **Ultralow Power Supply Current Drain . . . 60 μA Typ**
- **Low Input Biasing Current . . . 3 nA**
- **Low Input Offset Current . . . ±0.5 nA**
- **Low Input Offset Voltage . . . ±2 mV**
- **Common-Mode Input Voltage Includes Ground**
- **Output Voltage Compatible With MOS and CMOS Logic**
- **High Output Sink-Current Capability (30 mA at $V_O$ = 2V)**
- **Power Supply Input Reverse-Voltage Protected**
- **Single-Power-Supply Operation**
- **Pin-for-Pin Compatible With LM239, LM339, LM2901**

**D, J, OR N PACKAGE**
**(TOP VIEW)**




## description

The LP239, LP339, LP2901 are low-power quadruple differential comparators. Each device consists of four independent voltage comparators designed specifically to operate from a single power supply and typically to draw 60-μA drain current over a wide range of voltages. Operation from split power supplies is also possible and the ultralow power supply drain current is independent of the power supply voltage.

Applications include limit comparators, simple analog-to-digital converters, pulse generators, squarewave generators, time delay generators, voltage controlled oscillators, multivibrators, and high-voltage logic gates. The LP239, LP339, LP2901 were specifically designed to interface with the CMOS logic family. The ultralow power supply current makes these products desirable in battery-powered applications.

The LP239 is characterized for operation from – 25°C to 85°C. The LP339 is characterized for operation from 0°C to 70°C. The LP2901 is characterized for operation from – 40°C to 85°C.

**AVAILABLE OPTIONS**

| $T_A$ | $V_{IO}$max AT 25°C | PACKAGE | | |
|---|---|---|---|---|
| | | SMALL OUTLINE (D) | PLASTIC DIP (N) | CERAMIC DIP (J) |
| 0 °C to 70 °C | ±5 mV | LP339D | LP339N | LP339J |
| – 25 °C to 85 °C | ±5 mV | LP239D | LP239N | LP239J |
| – 40 °C to 85 °C | ±5 mV | LP2901D | LP2901N | LP2901J |

The D package is available taped-and-reeled. Add R suffix to device type when ordering (e.g., LP339DR).

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

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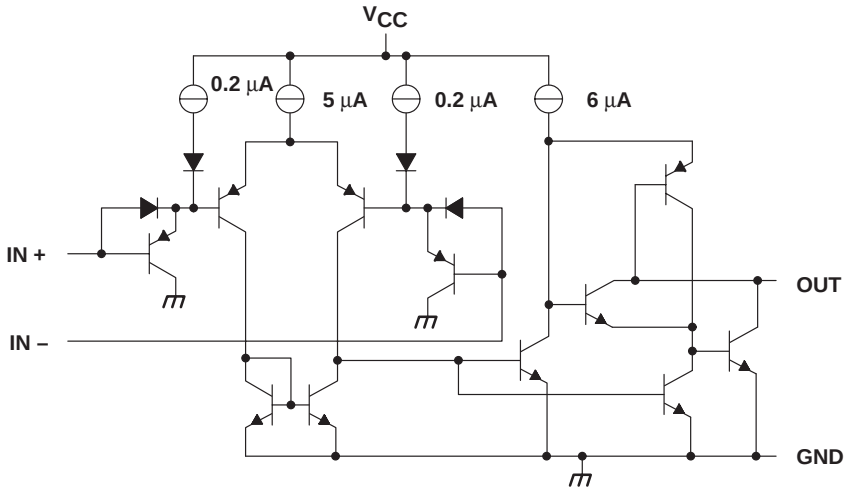
## schematic diagram (each comparator)




## absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage, $V_{CC}$ (see Note 1) . . . . . 36 V
Differential input voltage, $V_{ID}$ (see Note 2) . . . . . ±36 V
Input voltage range, $V_I$ (either input) . . . . . – 0.3 V to 36 V
Input current, $V_I \leq$ – 0.3 V (see Note 3) . . . . . – 50 mA
Duration of output short-circuit to ground (see Note 4) . . . . . Unlimited
Continuous total dissipation (see Note 5) . . . . . See Dissipation Rating Table
Operating free-air temperature range, $T_A$: LP239 . . . . . – 25°C to 85°C
LP339 . . . . . 0°C to 70°C
LP2901 . . . . . – 40°C to 85°C
Storage temperature range . . . . . – 65°C to 150°C
Lead temperature range 1,6 mm (1/16 inch) from case for 10 seconds: D or N package . . . . . 260°C
Lead temperature range 1,6 mm (1/16 inch) from case for 60 seconds: J package . . . . . 300°C

† Stresses beyond those listed under absolute maximum ratings may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the recommended operating conditions is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTES: 1. All voltage values, except differential voltages, are with respect to the network ground.
2. Differential voltages are at IN+ with respect to IN –.
3. This input current only exists when the voltage at any of the inputs is driven negative. The current flows through the collector-base junction of the input clamping device. In addition to the clamping device action, there is lateral n-p-n parasitic transistor action. This action is not destructive and normal output states are re-established when the input voltage returns to a value more positive than – 0.3 V at $T_A$ = 25°C.
4. Short circuits between outputs to $V_{CC}$ can cause excessive heating and eventual destruction.
5. If the output transistors are allowed to saturate, the low bias dissipation and the on-off characteristics of the outputs keep the dissipation very small (usually less than 100 mW).

**DISSIPATION RATING TABLE**

| PACKAGE | $T_A \leq 25°C$ POWER RATING | DERATING FACTOR ABOVE $T_A$ = 25°C | $T_A$ = 70°C POWER RATING | $T_A$ = 85°C POWER RATING |
|---|---|---|---|---|
| D | 950 mW | 7.6 mW/°C | 608 mW | 494 mW |
| J | 1025 mW | 8.2 mW/°C | 656 mW | 533 mW |
| N | 1150 mW | 9.2 mW/°C | 736 mW | 598 mW |

## recommended operating conditions

| | | | LP239 | | LP339 | | LP2901 | | UNIT |
|---|---|---|---|---|---|---|---|---|---|
| | | | MIN | MAX | MIN | MAX | MIN | MAX | |
| $V_{CC}$ | Supply voltage | | 5 | 30 | 5 | 30 | 5 | 30 | V |
| $V_{IC}$ | Common-mode input voltage | $V_{CC}$ = 5 V | 0 | 3 | 0 | 3 | 0 | 3 | V |
| | | $V_{CC}$ = 30 V | 0 | 28 | 0 | 28 | 0 | 28 | V |
| $V_I$ | Input voltage | $V_{CC}$ = 5 V | 0 | 3 | 0 | 3 | 0 | 3 | V |
| | | $V_{CC}$ = 30 V | 0 | 28 | 0 | 28 | 0 | 28 | V |
| $T_A$ | Operating free-air temperature | | – 25 | 85 | 0 | 70 | – 40 | 85 | °C |

## electrical characteristics, $V_{CC}$ = 5 V, $T_A$ = 25°C (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | | $T_A$† | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|---|
| $V_{IO}$ | Input offset voltage | $V_{CC}$ = 5 V to 30 V, RS = 0, | $V_O$ = 2 V, See Note 6 | 25°C | | ±2 | ±5 | mV |
| | | | | Full range | | | ±9 | |
| $I_{IO}$ | Input offset current | | | 25°C | | ±0.5 | ±5 | nA |
| | | | | Full range | | ±1 | ±15 | |
| $I_{IB}$ | Input bias current | See Note 7 | | 25°C | | – 2.5 | – 25 | nA |
| | | | | Full range | | – 4 | – 40 | |
| $V_{ICR}$ | Common-mode input voltage range | Single supply | | 25°C | 0 to $V_{CC}$ – 1.5 | | | V |
| | | | | Full range | 0 to $V_{CC}$ – 2 | | | |
| $A_{VD}$ | Large-signal differential voltage amplification | $V_{CC}$ = 15 V, | RL = 15 kΩ | | | 500 | | V/mV |
| | Output sink current | $V_{I-}$ = 1 V, $V_{I+}$ = 0 | $V_O$ = 2 V, See Note 8 | 25°C | 20 | 30 | | mA |
| | | | | Full range | 15 | | | |
| | | | $V_O$ = 0.4 V | 25°C | 0.2 | 0.7 | | |
| | Output leakage current | $V_{I+}$ = 1 V, $V_{I-}$ = 0 | $V_O$ = 5 V | 25°C | | 0.1 | | nA |
| | | | $V_O$ = 30 V | Full range | | | 1 | µA |
| $V_{ID}$ | Differential input voltage | $V_I \le 0$ (or $V_{CC-}$ on split supplies) | | | | | 36 | V |
| $I_{CC}$ | Supply current | $R_L$ = ∞ all comparators | | | | 60 | 100 | µA |

† Full range is –25°C to 85°C for the LP239, 0°C to 70°C for the LP339, and –40°C to 85°C for the LP2901.

NOTES: 6. $V_{IO}$ is measured over the full common-mode input voltage range.

7. Because of the p-n-p input stage, the direction of the current is out of the device. This current is essentially constant (i.e., independent of the output state). No loading change exists on the reference or input lines as long as the common-mode input voltage range is not exceeded.

8. The output sink current is a function of the output voltage. These devices have a bimodal output section that allows them to sink (via a Darlington connection) large currents at output voltages greater than 1.5 V, and smaller currents at output voltages less than 1.5 V.

## switching characteristics, $V_{CC}$ = 5 V, $T_A$ = 25°C, $R_L$ connected to 5 V through 5.1 kΩ

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|
| Large-signal response time | TTL logic swing, $V_{ref}$ = 1.4 V | | 1.3 | | µs |
| Response time | | | 8 | | |

## APPLICATION INFORMATION

Figure 1 shows the basic configuration for using the LP239, LP339, or LP2901 comparator. Figure 2 shows the diagram for using one of these comparators as a CMOS driver.

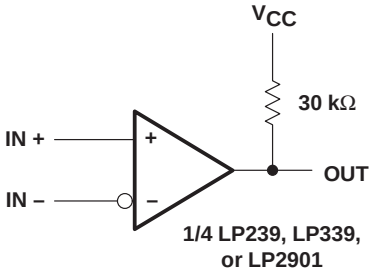



**Figure 1. Basic Comparator**

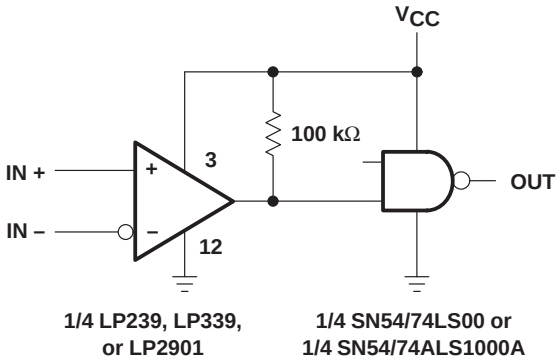



**Figure 2. CMOS Driver**

All pins of any unused comparators should be grounded. The bias network of the LP239, LP339, and LP2901 establishes a drain current that is independent of the magnitude of the power supply voltage over the range of 2 V to 30 V. It is usually necessary to use a bypass capacitor across the power supply line.

The differential input voltage may be larger than $V_{CC}$ without damaging the device. Protection should be provided to prevent the input voltages from going negative by more than – 0.3 V. The output section has two distinct modes of operation: a Darlington mode and a ground-emitter mode. This unique drive circuit permits the device to sink 30 mA at $V_O$ = 2 V in the Darlington mode and 700 μA at $V_O$ = 0.4 V in the ground-emitter mode. Figure 3 is a simplified schematic diagram of the output section. The output section is configured in a Darlington connection (ignoring Q3). If the output voltage is held high enough (above 1 V), Q1 is not saturated and the output current is limited only by the product of the $h_{FE}$ of Q1, the $h_{FE}$ of Q2, and I1 and the 60-Ω saturation resistance of Q2. The devices are capable of driving LEDs, relays, etc. in this mode while maintaining an ultralow power supply current of 60 μA typically.

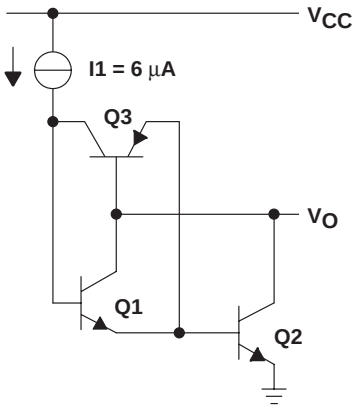



**Figure 3. Output-Section Schematic Diagram**

## APPLICATION INFORMATION

Without transistor Q3, if the output voltage were allowed to drop below 0.8 V, transistor Q1 would saturate and the output current would drop to zero. The circuit would be unable to pull low current loads down to ground or the negative supply, if used. Transistor Q3 has been included to bypass transistor Q1 under these conditions and apply the current I1 directly to the base of Q2. The output sink current is now approximately I1 times the $h_{FE}$ of Q2 (700 μA at $V_O$ = 0.4 V). The output of the devices exhibit a bimodal characteristic with a smooth transition between modes.

In both cases, the output is an uncommitted collector. Several outputs can be tied together to provide a dot logic function. An output pullup resistor can be connected to any available power supply voltage within the permitted power supply range, and there is no restriction on this voltage based on the magnitude of the voltage that is supplied to $V_{CC}$ of the package.

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